DECISION-MAKING UNDER UNCERTAINTY AND DEMAND FOR INSURANCE: AN EMPIRICAL STUDY

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Decision-making under uncertainty and demand for insurance: An empirical study

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Abstract

In this study we empirically estimated the role played by attitudes toward risk in insurance decision-making. To this end, we used the Iowa Gambling Task coupled with skin conductance recording, a validated experimental task of decision making under ambiguity which provides two dimensions of risk taking: the performance at the risk, as a measure of risk propensity, and the functioning of the somatic marker, as a measure of risk perception, that is the ability of the individual to “feel” the risk, independently of his/her risk attitude. The sample was made by 445 households and demographic-socio economical profiles were also obtained. Aside from confirming the role played by socio-economic explanatory variables, such as income level and marital status, on insurance purchase, results from the probit model showed the relevance of psychophysiological data: the likelihood of insurance demand is higher for people who are more risk seeking (worse performance at the task) but are adaptively able to feel the risk (anticipatory skin conductance responses to disadvantageous decks). Results are discussed in light of the need of interdisciplinary research.

Key words: insurance demand, decision making, ambiguity, risk taking, Iowa gambling task

JEL Classification: G22 (Insurance; Insurance Companies), D03 (Behavioral Economics; Underlying Principles), D81 (Criteria for Decision-Making under Risk and Uncertainty)
1. Introduction

The determinants of household insurance purchase have been analysed in many empirical research papers. Studies have looked at numerous observable demographic and economic factors that might be significant in explaining the demand for insurance, such as age, family size, marital status, education, income, and wealth; however, little work has been done on unobservable differences among individuals. In particular, given the uncertainty surrounding income or expenses shocks due to unexpected adverse events, inter-personal differences in risk preferences shall play an important role in household decision to purchase insurance, but the role played by attitudes towards risk has attracted somewhat limited attention in the empirical literature on insurance holding. The likely reason of such a gap of knowledge is that in the context of empirical analysis, there are obvious problems in measuring risk preferences at the household level.

In this paper, we focus on the relation between risk preferences and insurance demand at the household level, with the aim to contribute to cover this gap and to shed light on this relatively unexplored determinant of insurance purchase.

To this purpose, we use a unique dataset of 445 households who underwent a standardized experimental task, the Iowa Gambling Task (IGT; Bechara et al. 1996), coupled with skin conductance responses (SCR), and a series of questions related to their demographic-socio economical profile.

An in deep analysis of risk preferences on household insurance purchasing behaviour may be of great help in understanding “unobservable” differences among individuals and may also contribute to new discussion issues in the still growing literature on behavioural economics.
2. Literature review

There are several studies that help to explain the demand for insurance from a microeconomic perspective. These researches elicit a number of insights and illustrate how demographic characteristics - such as age, education, family size – and economic features - like income or household wealth - impact the decision to purchase insurance.

Empirical results are not always consistent across studies\(^1\), and in many cases the direction of socio-economic variables with insurance demand is found to be positive, negative or not significant. For example, as far as education, Burnett and Palmer (1984), Browne and Kim (1993) and, more recently, Lin and Grace (2007) find that higher education is associated with higher insurance demand, and the likely reason is that a more educated household has a greater likelihood of understanding the need for insurance. Conversely, Goldsmith (1983), focusing on life term insurance, shows that households with a more educated wife, \textit{ceteris paribus}, have a lower likelihood of purchasing insurance, suggesting that wife’s human capital serves as a substitute for such insurance. The size of the family, which intuitively is expected to be positively related with insurance purchase, in Auerbachand and Kotlikoff (1989) is found to be negatively related to insurance demand, while in Anderson and Nevin (1975) is not significant in determining insurance holding. The relation between age and insurance demand is ambiguous as well. Gandolfi and Miners (1996) find a negative relation, while Showers and Shotick (1994) show that insurance is positively related to age. Lin and Grace (2007) and Bernheim (2001) do not find a significant relationship between

\(^1\) For a comprehensive review of the academic literature on life insurance see Zietz (2003).
age and insurance purchase: older people may have a greater desire to leave a bequest, however they may have a binding budget constraint when approaching retirement.

Income, like wealth, is found to have ambiguous effects on insurance demand, depending upon a consumer’s risk tolerance. In fact, although the majority of studies find that income positively affect insurance purchase and suggest that as income increases new types of risks arise (Burnett and Palmer 1984; Gandolfi and Miners 1996; Li et al. 2007), Browne and Kim (1993) and Anderson and Nevin (1975) find a negative relation between income and insurance demand, while Berekson (1972) find that the variable income is not significant. Similarly for the effect of wealth, many studies show that households increase their insurance demand with increasing wealth (Bernheim 1991; Duker 1969; Lewis 1989), but Fortune (1973) finds a negative relationship and suggests that, as wealth increases, an individual may decide to mainly put incremental wealth into saving because he thinks he can handle risks with his improved economic strength. Again, other authors (Auerbach and Kotlikoff 1989; Fitzgerald 1987) show nonsignificant findings.

The overall ambiguity of the results underlines the need to further investigate the determinants of insurance demand and to update research in this rather unexplored field of research; indeed, although the expected utility model has provided the primary theoretical tool by which economists have examined insurance demand, recent data confirm that individuals do not follow the dictates of this model when deciding whether or not to buy insurance (e.g., Neilson 2002; Mason et al. 2005).

Moreover, the existing literature do not give much insight into the role of risk preferences over households insurance purchase. Indeed, the impact that a consumer’s degree of risk aversion has on insurance purchasing behaviour has been mainly
addressed on a theoretical level in the economic literature; in this perspective, the level of risk aversion is supposed to be positively correlated with insurance demand.

Fortune (1973), in applying the expected utility hypothesis of choice under uncertainty to the explanation of the optimal amount of life insurance for a rational individual, demonstrates that an increase in absolute risk aversion indicates less willingness to take a given risk and will increase the insurance premium one is willing to pay to reduce risks. Eisenhauer (2004), within a theoretical framework of adverse selection, analyse the effect of risk and risk aversion on insurance demand and argues that if low-risk applicant are more risk averse than their high-risk counterparts, the former will be as willing or more willing than the latter to purchase insurance at any given price.

Although other authors examine, from a theoretical perspective, the impact of risk aversion on insurance purchasing behaviour (Hoy and Robson 1981; Szpiro 1985), little work has been done empirically. Specifically, we are aware of the existence of few studies that empirically direct test risk aversion on insurance purchase, and the results are contradictory: Schlesinger (1981) examines the optimal choice of deductibles when purchasing insurance and finds that a consumer’s level of risk aversion is directly related to how much coverage he will purchase; Burnett and Palmer (1984), examining life insurance ownership through demographic and psychographic characteristics, find that owners of large amounts of life insurance among other things tend to be greater risk takers. More recently, Jacobson and Petrie (2009) demonstrate that there is no relationship between risk aversion and being a member of an insurance group.

The reason of such a scarcity of works and ambiguous results lies on the evidence that examining risk attitudes and their effects on individuals is difficult in an empirical
setting. Also, risk taking seems to be highly domain specific, such that one might find very different attitudes toward risk taking in financial versus health versus social situations (Hanoch et al. 2006). The same person can therefore behave as both risk averse and risk seeking in different situations. As a consequence, neither psychologists nor economists have been particularly successful in developing a single psychological questionnaire to predict risk taking behaviour across multiple domains (Nicholson et al. 2002), thus, the topic has started to be addressed from a biological point of view.

Thanks to explicit interdisciplinary, multimethodological and theoretically integrative research -the so-called neuroeconomy- it has been possible to address some key questions, shedding light on the crucial difference between decisions under ambiguity and under risk.

In situations of decisions under ambiguity, the consequences of the decision are completely undefined and we do not have any information about how likely positive or negative consequences will appear (Bechara 2004). On the other hand, in situations of decisions under risk, the consequences are known and the outcomes can be specified, even probabilistically (Brand et al. 2006). Hogarth and Kunreuther (1989) emphasized the importance of ambiguity on insurance markets. For example, people tend to buy flood or earthquake insurance coverage only after experiencing a disaster or learning of others who have suffered severe damage.

It seems evident that many real world decisions (e.g., the demand for insurance) have a more complex form of uncertainty compared to risk, because the distribution of outcomes is itself unknown. The emerging neuroscientific evidence suggests that these two mechanisms are subserved by separate neural processes. For example, oral administration of the serotonin precursor 5-hydroxytryptophan specifically impairs
decision making under ambiguity but not under risk (Gendle and Golding 2010). Also, there is evidence that normal aging affects decisions under ambiguity, but not decisions under risk (Zamarian et al. 2008). Shiv et al. (2005) proposed that emotion may be disruptive to one mechanism, but not the other. Specifically, it seems that emotion plays a positive role in decision-making in tasks of decisions under ambiguity and a negative role in decision making in tasks of decision making under risk. Accordingly, cognitive reappraisal of negative emotions reduces risk aversion in tasks of decision under risk but increases the performance at the IGT (Heilman et al. 2010).

The IGT was originally developed to explain decision making deficits in people with specific frontal lobe damage but is now considered a standardized task to investigate decision-making under ambiguous conditions. In these situations individuals use somatic markers (Somatic Marker Hypothesis, Damasio 1994), such as SCR, which constrain the complexity of the situation and permit the individual to decide efficiently. The somatic marker hypothesis provides neurobiological evidence in support of the notion that people often make judgments based on “hunches,” “gut feelings,” and subjective evaluation of the consequences (Damasio 1994). To our knowledge, this is the first study that tested the relationship between risk propensity and insurance demand by the use of a validated experimental task of decision making under ambiguity. The advantages rely on the fact that the IGT provides two dimensions of risk taking: the performance at the task as a measure of risk propensity and the functioning of the somatic marker as a measure of risk perception, that is the ability of the individual to “feel” the risk, independently of his/her risk attitude. In our opinion, the latter might constitute a crucial variable to uncover previous ambiguous results in the link between risk aversion and insurance demand.
3. Data and variables

3.1 The sample and the data collection

Present data were obtained from a larger data set collected during a 2-year study funded by the National government (PRIN2007- MIUR) with the major aim of investigating the role of emotions in financial decision-making. The sample was composed by 445 Caucasian subjects, randomly selected among investors and full time employees at international asset management societies. Informed consent was obtained from all participants.

All subjects underwent a series of questions about demographic-socio economical information\(^2\), the IGT and physiological data collection. As far as the IGT, we used a computerized version of the task based on the original as described in Bechara et al. (1996). In this version, participants see four decks of cards labelled A, B, C, and D and a starting amount of fiches on a computer screen. The subjects are instructed to maximize gains and minimize losses when playing the game. Using the corresponding key on the board, subjects can select a card on any of the four decks. Each card carries an immediate reward (100 Euros in decks A and B and 50 Euros in decks C and D). Unpredictably, however, the turning of some cards also carries a penalty (which is larger in decks A and B and smaller in decks C and D). Playing mostly from decks A and B leads to an overall loss. Playing from decks C and D leads to an overall gain. Moreover, choices can be risky in terms of future gain (A, B vs. C, D) and in terms of punishment frequency (A, C vs. B, D). The players cannot predict when a penalty will

\(^2\) The questionnaire is available from the authors on request.
occur, nor calculate with precision the net gain or loss from each deck. They also do not know how many cards must be turned before the end of the game (the game in fact ends after 100 card selections). Participants are asked to play so as to win the most money. The computer tracks the sequence of the cards selected from the various decks. The task duration was about 30 min for each participant.

Electrodermal responses (SCRs) were recorded using the Biopac MP150 system (Biopac Systems, CA, USA) via two TSD203 electrodes filled with isotonic gel and attached to the volar surfaces of the index and middle fingers of the non-dominant hand. Recording of the SCRs started at the beginning of the IGT after the subject had been seated in a comfortable chair for 10 min. Sample rate was set at 1 Hz. As the subject performed the task, SCR activity was recorded continuously and collected simultaneously on a personal computer. Each time the subject clicked the mouse and selected a card, the action was recorded as a “mark” on the polygram of SCR activity. Each click was registered as a selection from the specific deck that had been chosen. Thus, the SCRs generated in association with a specific deck could be identified precisely on the polygram. Although the intertrial interval was set at 6 s, to allow for psychophysiological recordings, in reality the time interval between 2 card selections was longer, because it took a few additional seconds for the subject to decide which card to pick next. This time interval varied from trial to trial (10 s on average). During the 6 s intertrial interval the decks were displayed continuously on the screen, and the subject could ponder which deck to choose next. All the participants included in this study displayed SCRs during the IGT. From SCR recordings, we extracted the area under the curve (mS/s) of SCRs in the intervals of interest, that is the 5 s before the next card selection (anticipatory SCRs) and the 5 s immediately after the click of a card.
(reward and punishment SCRs). For each subject, we obtained anticipatory and punishment SCRs before and after the disadvantageous decks, respectively. Data were stored on a personal computer, and analyzed offline using the software AcqKnowledge 3.8.

To score the performance at the task (IGT_score), we added the total number of cards picked from decks C and D, and subtracted the total number of cards picked from decks A and B.

3.2 The econometric model

We used a probit model in order to study how the probability of holding insurance \( (D^* > 0) \) varies according to individual characteristics. Specifically, our dependent variable is equal to 1 if the household holds a health insurance product, 0 otherwise.

We focus on the probability of holding health insurance rather than life insurance products since we are not able to distinguish between term life insurance products and other life insurance products (e.g. index linked or unit linked); in this second case, the main goal of the insurance product is to provide a financial return to the household investment rather than to manage a pure risk and, in turn, the determinants of the demand are those typically analysed in a framework of financial investment decisions. Conversely, health insurance purchase does have the underlying ratio of hedging a risk, and better fits with the aim of our paper, that is to analyse the determinants of insurance holding.

The model is as follows:

\[
P(D^* > 0) = \Phi(\beta'X)
\]
where $\Phi$ indicates the distribution function of a standard normal random variable, $X$ is the vector of observable regressors and $\beta$ is a vector of parameters.

The model includes the different explanatory variables commonly used in the applied literature to analyze the determinants of household insurance holding. Our specific feature consists in using an additional explanatory variable in order to capture

Table 1 synthesizes individual characteristics of the sample concerning the variables used. The percentage of households holding health insurance totalled 44.5%.

<Insert table 1>

4. Empirical results

Estimation results in Table 2 are presented according to the model described above and reported in terms of variation of the estimated probability when switching from the reference category to the category of interest, i.e. “marginal effects” (Greene 2008). Analysis are robust to heteroskedasticity.

<Insert table 2>

In line with previous findings (Burnett and Palmer 1984; Lin and Grace 2007; Showers and Shotick 1994), the probability of having health insurance increases by 25% moving from a lower to a higher level of income. This result is consistent with the fact that a higher income level increases the affordability of insurance products;
moreover, specifically regarding the case of health insurance, a large income results in a
greater loss of expected utility in the event of the income earner’s illness or injury. As
far as the work status, the probability of having insurance drops dramatically for not-
employees compared to the reference category (-56%); Duker (1969), Feber and Lee
(1980) and Miller (1985) find a similar result.

Reflecting the conflicting indications of previous studies that have sought to
determine the effect of net wealth on insurance demand, we find that net wealth is not
significant, in line with Fitzgerald (1987) and Auerbach and Kotlikoff (1989).

Socio-demographic variables appear to play a rather significant role in insurance
holding in line with Burnett and Palmer (1984), Gandolfi and Miners (1996), Duker
(1969), Anderson and Nevin (1975). In particular, being married increases the
probability of having health insurance by 27%, while the size of the family, the age of
the household head and his/her level of education were not significant in the model.

On the overall, findings related to the effect of socio-economic variables on
insurance purchase are consistent with the existing literature.

As far as psychological variables, results show that the “anticipatory SCR” and the
IGT_score are determinants of insurance purchase, while the “punishment SCR” score
is not significant. In particular, the variable “anticipatory SCR” is significant and the
sign is positive; that is an intact somatic marker reaction to risky choices increases the
probability of having insurance. Conversely, the variable IGT_score is significant and
the sign is negative; a higher level of risk propensity reduces the probability of holding
insurance.

5. Conclusions
Decisions regarding insurance depend crucially on the extent to which individuals are willing to bear risk. For a risk averse individual, the method for reducing the expected financial impact of a loss include reducing the severity of any loss that occurs (self insurance). Accordingly, Dionne and Eeckhoudt (1985) showed that a more risk averse consumer would always invest more in self-insurance activities. If this is true, then the "wrong" people are buying insurance protection (Hemenway 1992). For example, risk tolerant drivers are less likely to choose broader coverage contracts even if they are more likely to incur accidents and risk averse agents tend to purchase more insurance coverage (Barsky et al. 1997; Blows et al. 2003). On the contrary, our results showed that higher risk propensity, as suggested by lower performance at the IGT, predicts larger insurance demand. This seems counterintuitive, as risk aversion seems to be the central reason why individuals purchase insurance and undertake other forms of risk management. Present findings are, however, in agreement with Burnett and Palmer (1994) who demonstrated that the owners of large amounts of life insurance tend to be greater risk takers, Briys and Schlesinger (1990) who found that a more risk-averse person may actually utilize a lower level of self protection, and Doherty (1984) who concluded that risk averse consumers will find insurance superfluous in well-diversified portfolios. Others suggested that more risk averse individuals have a higher willingness to pay, only if the probability of accident is lower than ½ (Dachraqui et al. 2004).

A possible explanation for these contradictions may rely into the different methods that have been used as a measure for risk propensity. Previous researchers mainly used self-report or theoretical/artificial taxonomies and, to our knowledge, this is the first study in which risk attitude was empirically tested with the use of a validated
experimental task of decision under ambiguity. Although discussed controversially (see Dunn et al. 2006 for a review), the interpretation of IGT is grounded on the importance of emotional processes in deciding advantageously (e.g., Bechara and Damasio 2002; Brand et al. 2007; Denburg et al. 2006). In fact, reduced functioning of somatic markers normally biases individuals against a disadvantageous decision (Damasio et al. 2002). Interestingly, participants in our sample who are more likely to demand for insurance are those who are more risk seeking (worse performance at the IGT) but are adaptively able to feel the risk (higher anticipatory SCR to disadvantageous decks). Normal subjects who performed poorly on the IGT but generate appropriate anticipatory SCRs usually describe themselves as high-risk takers, thrill seekers, or gamblers in real-life (Bechara et al. 2002). This result might shed light into previous contradictory findings: in fact, we can speculate that these subjects are those who are likely to be aware of their risk attitude and its consequences, thus, are those who feel the need to protect themselves from the potential losses related to their behaviors.

McGuire et al. (1991) interpreted gambling as a way to increase small chances of good outcomes and insurance as a way to reduce small chances of bad outcomes. The authors found a critical switching probability that depends on the outcomes involved and the individuals. With regard to the outcome, if the good outcome is less likely than this critical value, the expenditures represent gambling, if it is more likely than this critical value, the expenditures represent insurance. As far as the individuals, present findings seem to suggest that the switching probability might be determined by the somatic marker functioning. Our findings are in line with Rubaltelli et al (2010) who recently proposed affective reactions as the potential mechanism causing ambiguity aversion (Hazen and Lee 1991). In fact, the somatic marker can easily be described as
the physiological manifestation of an emotional state that guides decision under ambiguity.

The present study is not without limitations. First, almost two third of our sample is composed by highly educated experts in economics and finance. Second, it is likely that a number of other psychological variables interact with risk propensity in determining insurance demand, such as, for example, self-confidence. In general, this is an underexamined topic and our study is meant to be preliminary. In light of such intriguing findings, we can conclude that fundamental advances in the study of the link between risk propensity and insurance demand will only arise from the reciprocal integration of expertise and techniques across traditionally independent fields.
Acknowledgements

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References


Table 1. Households socio-demographic, economic and psychological characteristics.

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<th>Variables</th>
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<td>Participation in the insurance market</td>
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<td><strong>IGT_score</strong></td>
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Table 2. Participation in the insurance market: Probit estimation.

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